U.S. Department of Commerce, Bureau of Standards

RESEARCH PAPER RP628

Part of Bureau of Standards Journal of Research, Vol. 11, December 1933

SPECTRAL REFLECTANCE OF THE PHILIPPINE ISLAND GOVERNMENT STANDARDS FOR ABACÁ FIBER

By Genevieve Becker [1]

ABSTRACT

This paper reports the results of spectral reflection measurements of one set of the official standards for the grades of abacá used in cordage. The results provide a quantitative record of those characteristics of the fiber on which the color depends. They should be of permanent value since the grading is largely on the basis of color. They suggest the possibility of using quantitative reflectance measurements in the Philippine Islands to supplement, if not to replace, the present method of grading abacá for color. Three specimens representing the base, tip, and middle of each of 10 standard samples were measured at seven wave lengths. The average values found for the spectral reflectance at wave length 500 mμ, which are illustrative of the results, follow: Superior current 59.3, good current 54.9, midway 49.9, 25 percent over fair current 46.5, streaky two 45.4, streaky three 33.5, fair current 42.5, superior seconds 40.0, soft seconds 31.3, soft brown 21.5. The highest and lowest measurement for a given standard differ by from 2 to 13 units and there is decided overlapping in the measurements for some of the different grades.

CONTENTS

I. INTRODUCTION

A method for evaluating the color of abacá fiber in rope, by means of spectral reflection measurements has been described.[2] The method is used in the revised specification for manila rope [3] which prescribes minimum reflectance values for rope for government purchase. Formerly the permissible grades of fiber and proportions of these grades were specified.[4] Thus it becomes of interest to know the reflectance values for the commercial grades of abacá.

The grading of abacá fiber is done in the Philippine Islands where most of the fiber of commerce is grown. It consists of practical hand tests and visual examination by inspectors of the Fiber Standardization Board. The grade of the fiber depends upon three factors: Strength, "cleaning," and color. A certain basic strength is required for all abacá included in the standard grades. Cleaning determines the group of grades under which the fiber is classified. Color determines the actual grade of the fiber within that group. The three

[1] Research associate at the Bureau of Standards for the Cordage Institute.
[2] Evaluation of Manila Rope Fiber for Color, Genevieve Becker and Wm. D. Appel, B.S.Jour. Research, vol. 11 (RP 627), p. 811.
[3] F.S. no. T-R-601, Rope, Manila, 8 p., Mar. 7, 1933. Government Printing Office, Washington, D.C.
[4] F.S. no. 61b, Rope, Manila, 5 p., 1929, Government Printing Office, Washington, D.C.

properties are closely related, for the kind and extent of cleaning affect both tensile strength and color. The standard grades of abacá fiber are described in administrative order no. 7 of the Fiber Standardization Board.[5] They are represented by standard samples obtainable from the Board.

This paper reports the results of spectral-reflection measurements of one set of the official standards for the grades of abacá used in cordage. The results provide a quantitative record of those characteristics of the fiber on which the color depends and therefore they should be of permanent value. They suggest the possibility of using quantitative spectral reflectance measurements in the Philippine Islands to supplement, if not to replace, the present method of grading abacá for color.

This work was not concerned with the relation between the color of fiber and the serviceability of rope made from it.

The work was undertaken at the suggestion of the Cordage Institute, J. S. McDaniel, secretary, and was made possible by the financial support of the institute.

II. MATERIALS

A set of 10 samples bearing the official Philippine Island Government stamp was provided by the Cordage Institute on February 16, 1933. These samples represent the Philippine Island Government standards for the following commercial fiber grades:

Letter designation	Name of grade
AB	Superior current
CD	Good current
E	Midway
F	25 percent over fair current
S2	Streaky two
S3	Streaky three
I	Fair current
J1	Superior seconds
G	Soft seconds
H	Soft brown

The samples were in the form of bundles of fiber ranging from 5 feet 2 inches to 7 feet in length and approximately 8 inches in circumference. Microscopic examination of representative fibers from the samples showed that the diameters of individual fibers varied from 0.08 to 0.50 mm. Samples representing the lower grades of fiber exhibited considerable variation in color; the upper grades were more nearly uniform in this respect.

III. PROCEDURE

Three specimens, (a), (b), and (c), were taken from each of the standard samples. Specimen (a) was taken from the extreme base of the standard sample; specimen (b), because of considerable fraying out and the broken condition of the fibers at this end, was taken at a distance of about 1 foot from the extreme tip; specimen (c) was taken at a distance half-way between specimens (a) and (b). Each specimen weighed about 12 ounces and was a complete cross-section of the

[5] Fiber Standardization Board administrative order no. 7. Determination and Description of the Official Standards for the Various Commercial Grades of Certain Philippine Fibers. 16 pp. 1932. Department of Agriculture and Natural Resources, Manila, P.I.

bundle. Each was reduced to a finely chopped condition by cutting the fibers to lengths of 1.5 to 2.5 mm with a meat cutter having a revolving blade. The chopped fibers were thoroughly mixed, bottled, and kept in a dark place until measured.

The equipment used for determining the spectral reflectance of the fiber [6] and the method for preparing the fiber surface for measurement have already been described in detail.[7] The method consists essentially of placing the fiber in a black container approximately 4 mm deep, pressing and smoothing it with a spatula to obtain a flat, smooth surface. The reflectance of this surface relative to that of a standard white magnesium oxide surface was determined for light of seven wave lengths for the following conditions: (1) The sample and standard-white surface were in effect under equal illumination, (2) the angle of incidence of the light was approximately 45° and, (3) the direction in which the reflectance was measured was perpendicular to the plane of the surfaces of sample and standard. This reflectance ratio multiplied by 100 is the reflectance in percent reported in the figures and in table 1.

TABLE 1.—*Spectral reflectance of a set of the Philippine Island Government standards for abacá fiber*

[The values given are the spectral reflectance in percent relative to magnesium oxide, when sample and standard are in effect equally illuminated at an angle of approximately 45° and the line of sight is approximately perpendicular to the surfaces]

Philippine Island letter designation and name of grade	Location of specimen in the standard hank [a]	Reflectance (in percent) at wave lengths (millimicrons)						
		703	651	578	546.1	[b] 500	436.8	405
AB—Superior current	a	80.8	77.2	69.8	65.4	60.2	49.5	39.0
	b	74.5	71.7	65.9	62.6	57.8	45.9	34.0
	c	80.6	76.6	70.0	66.3	59.9	48.8	37.4
Average		78.6	75.2	68.6	64.8	59.3	48.1	36.8
CD—Good current	a	80.6	76.0	67.2	66.0	57.8	47.8	36.2
	b	69.6	66.4	59.6	55.9	49.7	40.8	29.5
	c	80.2	76.2	67.9	63.4	57.2	46.2	35.4
Average		76.8	72.9	64.9	61.8	54.9	44.9	33.7
E—Midway	a	77.2	73.0	64.2	61.2	53.3	43.4	36.8
	b	71.4	68.4	56.9	53.8	46.9	36.1	27.9
	c	76.9	71.4	61.3	56.9	49.5	39.3	32.0
Average		75.2	70.9	60.8	57.3	49.9	39.6	32.2
F—25 percent over fair current	a	74.4	69.6	59.2	55.5	48.7	38.7	29.6
	b	69.8	65.1	56.1	51.6	44.9	34.4	25.6
	c	75.0	69.4	58.2	53.2	45.8	35.3	27.6
Average		73.1	68.0	57.8	53.4	46.5	36.1	27.6
S2—Streaky two	a	74.6	68.8	59.3	54.8	49.4	38.0	29.7
	b	69.5	64.3	54.2	49.1	42.2	32.6	25.6
	c	71.8	66.6	56.6	51.6	44.7	35.1	27.7
Average		72.0	66.6	56.7	51.8	45.4	35.2	27.7

[a] Location of specimen in the standard hank: a, base; b, tip; c, middle.
[b] The values in this column are the "Becker values" for the fibers.

[6] Wm. D. Appel, A Method for Measuring the Color of Textiles. Am. Dyestuff Reptr., vol. 17, p. 49, Jan. 23, 1928.
[7] See footnote 2, p. 823.

TABLE 1.—*Spectral reflectance of a set of the Philippine Island Government standards for abacá fiber*—Continued

Philippine Island letter designation and name of grade	Location of specimen in the standard hank [a]	Reflectance (in percent) at wave lengths (millimicrons)—						
		703	651	578	546.1	[b] 500	436.8	405
S3—Streaky three	a	70.2	64.2	53.2	48.1	41.8	33.4	26.1
	b	59.8	52.0	40.7	36.5	30.0	22.4	18.0
	c	57.2	49.5	40.6	35.7	28.7	22.3	18.0
Average		62.4	55.2	44.8	40.1	33.5	26.0	20.7
I—Fair current	a	75.0	69.8	57.8	53.0	46.0	36.0	28.9
	b	71.4	64.8	53.1	44.6	40.3	30.5	24.1
	c	73.0	66.6	53.7	48.9	41.1	31.7	25.4
Average		73.1	67.1	54.9	48.8	42.5	32.7	26.1
J1—Superior seconds	a	72.2	68.6	58.0	53.0	45.4	35.8	28.4
	b	68.4	62.1	50.8	45.8	38.1	29.2	22.1
	c	69.4	62.0	49.5	44.2	36.6	27.8	22.4
Average		70.0	64.2	52.8	47.7	40.0	30.9	24.3
G—Soft seconds	a	67.4	58.8	46.3	42.1	35.4	26.0	21.6
	b	58.9	52.0	41.7	36.6	30.1	22.1	17.6
	c	60.8	52.0	40.1	35.5	28.3	20.4	16.3
Average		62.4	54.3	42.7	38.1	31.3	22.8	18.5
H—Soft brown	a	49.3	38.9	31.7	28.3	23.3	17.8	14.5
	b	44.6	36.2	29.8	26.0	21.1	15.2	12.1
	c	45.3	36.5	28.9	25.4	20.0	14.3	11.5
Average		46.4	37.2	30.1	26.6	21.5	15.8	12.7

[a] Location of specimen in the standard hank: a base; b, tip; c, middle.
[b] The values in this column are the "Becker values" for the fibers.

IV. RESULTS

The results of the measurements are recorded in numerical form in table 1. The average for the specimens from the base, tip, and middle of each standard is also given.

The average data are plotted in the form of curves in figure 1. In general, the curves have the same shape, the order of the values being that of the standard grades listed under section II of this paper, except that the values for the grade S3 are lower than those for grades I and J1.

The variation in spectral reflectance between specimens from the base, tip, and middle of the standards for the grades commercially used in rope is shown in figure 2. The reflectance of specimens from the base is usually higher than that of specimens from the tip and middle.

The maximum observed variation in spectral reflectance for each standard at each of the seven wave lengths and the overlapping between grades is illustrated in figure 3. The highest and lowest value for a given grade differ by 2 to 13 units. The great variation, 13 units, in grade S3, is a result of the very dark bundles of fiber in it which give it a streaky appearance. They account for the low value of the average spectral reflectance and the position of the curve for S3 in figure 1.

In figure 4 are plotted the reflectances at wave length 500 mμ of the specimens from each standard. The reflectance of a rope fiber at this wave length relative to that of magnesium oxide is the Becker value of the Federal Specification for manila rope.[8] The minimum

[8] See footnote 3, page 823.

values for rope for Government purchase are: 46 for rope ½ to 2 inches in nominal circumference, inclusive; 43 for rope 2¼ inches

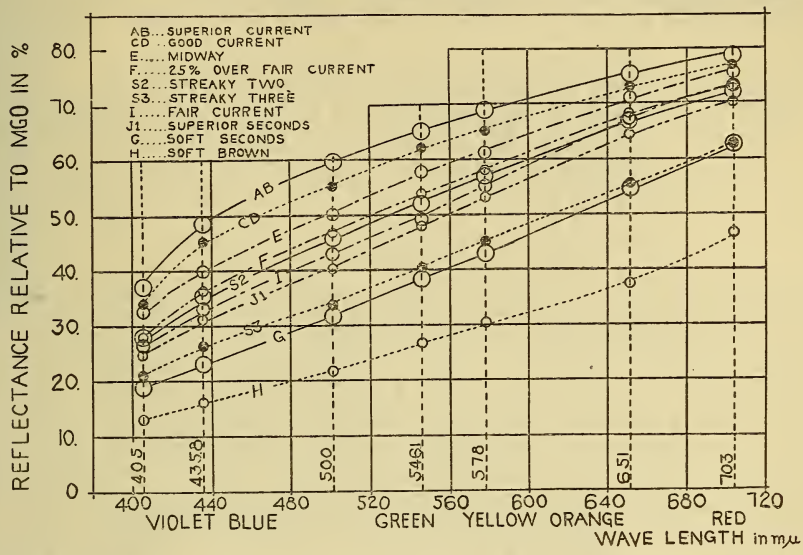

FIGURE 1.—*Spectral reflectance of the Philippine Island Government standards for abacá fiber. Each point is the average reflectance of specimens taken from the base, middle, and tip of the standards.*

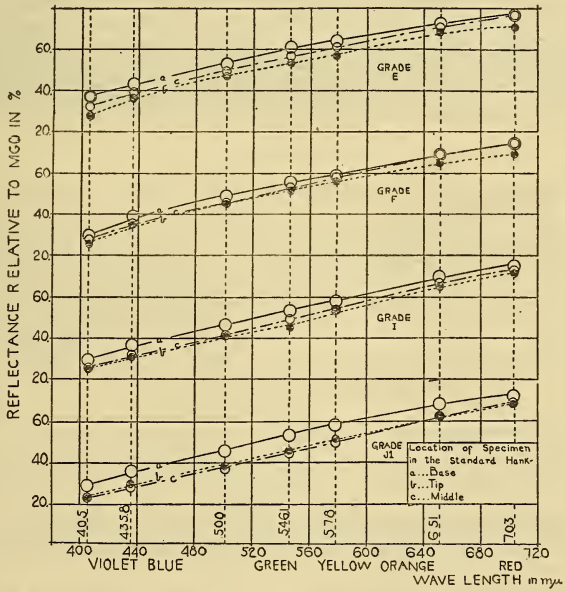

FIGURE 2.—*Spectral reflectance of the Philippine Island Government standards for the commercial grades used in manila rope, showing the variation between specimens taken from the base, middle, and tip of the standards.*

in nominal circumference and above. The average Becker values for the standards for grades commonly used in rope are: for grade

E 49.9, F 46.5, I 42.5, and J1 40.0. Thus the E and F grade standards meet the requirement for smaller ropes, but the I and J1 grade standards have average Becker values too low for use in any of the ropes except in mixture with higher grade fiber. Grade S2

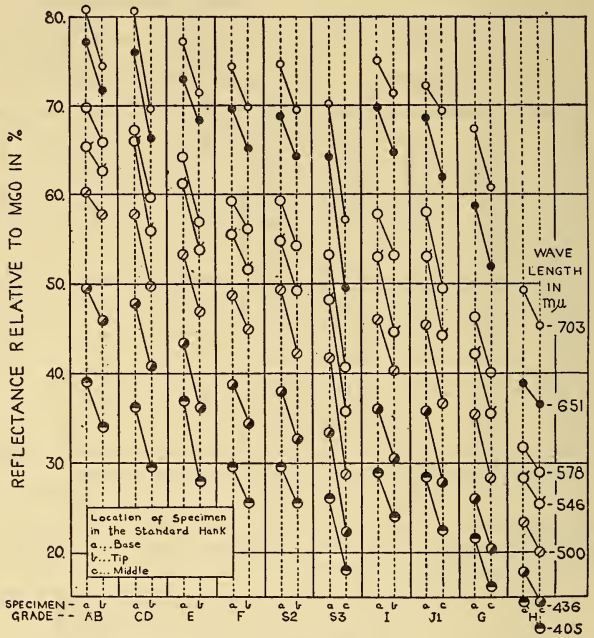

FIGURE 3.—*Spectral reflectance of two specimens for each Philippine Island Government standard showing the maximum variation in each grade and the overlapping between grades. The data for each wave length are indicated by circles of the same character. See right-hand side of chart.*

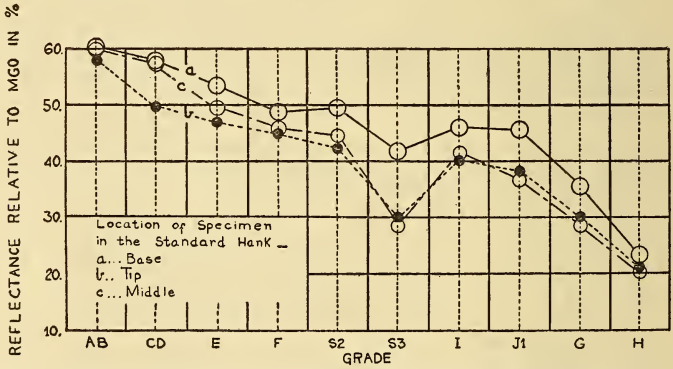

FIGURE 4.—*Spectral reflectance at wave length 500 mμ of specimens from the base, middle, and tip of the Philippine Island Government standards for abacá fiber.*

appears to be suitable for use in rope made to meet the specifications insofar as color is concerned.

It should be remembered that the fiber in commercial bales of abacá may vary more in reflectance than the fibers in the standards measured.

WASHINGTON, October 18, 1933.